

Estimated Costs of Landfill Closure

What does it mean to "cap" a landfill?

The principle cause of groundwater pollution at landfills is the infiltration of water - rainwater and snowmelt - into the refuse. This water filters through the refuse, which dissolves a wide range of water-soluble pollutants out of the refuse, and encourages microbiological decay which releases even more contaminants. This mix of dissolved and suspended chemicals and rainwater is called "leachate." Modern sanitary landfills are designed with liners of plastic and clay, leachate collection systems, and leachate storage facilities designed to intercept, collect, and contain the leachate, and hold it for treatment at the site or elsewhere. In unlined landfills, nothing but natural earth materials retard the migration of leachate into the groundwater. Some natural processes help reduce the concentration of many chemicals once leachate has migrated from the landfill, but in many instances groundwater contaminated by unlined landfills has been found to contain one or several chemicals at concentrations above the drinking water standards set by the United States Environmental Protection Agency (EPA).

In order to mitigate this environmental damage and threat to public health, landfills are permanently closed with low-permeability caps which cut off the infiltration of water into the refuse. Caps are useful even at lined sites, because they limit the amount of leachate that must be treated. At unlined sites, they are even more critical, and serve as a principal remedial technique to limit or prevent leachate migration, and reduce the need for other expensive techniques such as groundwater pumping.

What does a cap cost?

Installation of a cap costs between \$80,000 and \$500,000 per acre. Typical costs for a Maryland sanitary landfill are approximately \$150,000 per acre. The actual costs depend largely on the local availability of materials used to construct the cap, the topography and ease of installation at a particular site, the design selected, and cost reductions associated with bulk-buying. For example, if substantial quantities of clay are available nearby, and the clay is suitable for this use, it can eliminate the cost of purchasing the low permeability layer - although it will still entail excavation, installation, compaction, and testing costs. Where gravel is present, then the drainage layer could be composed of locally-available material. The costs described are the capital costs for installation, and do not include other costs.

What other costs are involved in landfill closure?

Under new Federal regulations governing landfill closure, landfills must monitor, inspect and maintain the landfill and its protective systems for at least 30 years following facility closure. This includes operation of the leachate collection system, extensive groundwater monitoring, inspection and repair as needed of the cap and other protective systems, and maintenance of the financial assurance bond or other security. Also, facilities which develop groundwater contamination have to institute remedial activities such as groundwater pumping and treatment, expanded monitoring, and additional financial assurance. Finally, in addition to water pollution, landfills have another byproduct: landfill gas. This gas is created by the anaerobic decay of putrescible materials such as food waste, paper and wood, and is largely composed of carbon dioxide (CO₂) and methane (CH₄).

Methane can migrate through the soil, and concentrate in enclosed structures, causing natural gas explosions and flash fires. Volatile Organic Chemicals (VOCs) such as benzene, chlorinated solvents, and Freons which are present in domestic refuse in small amounts can travel with the landfill gas, and degrade the ozone layer. Controls on these gases involve the installation of collection wells under the cap. Blowers and header pipes are used to collect the gas at a central point, where it is flared off (destroying the methane and VOCs) or used as fuel. Some facilities in Maryland recover some cost back by using the landfill gas to fuel boilers or generators, or even treat the gas and provide it to the local gas utility. The installation of gas controls is being expanded due to increased requirements to control non-methane VOCs

under the federal Clean Air Act. However, the additional systems needed to collect and destroy or use the gas add approximately \$10,000 to \$20,000 per acre, plus operation and maintenance costs.

What goes into a cap?

A cap is constructed of several layers, applied one at a time over areas of the landfill until the entire filled area is covered. Over the last layer of refuse, a two foot layer of soil called the "final cover" is installed to protect the cap from damage by sharp objects or settlement of the waste. This surface is graded to a 4% minimum slope to insure drainage, and compacted for stability. Then, a low permeability layer consisting of 12 to 18 inches of clay with a maximum permeability of 1×10^{-5} cm/sec, or more frequently a flexible membrane of PVC, HDPE, or a similar plastic is placed on the landfill. For clay, the permeability, density, and moisture content is measured and adjusted to assure minimum permeability; for plastic, the seams are sealed and tested to insure a leak-free cap.

A 6" drainage blanket of sand or gravel, or sometimes a plastic drainage media, is applied on top of the liner. This blanket must have a minimum permeability of 1×10^{-3} cm/sec. Often a permeable geosynthetic fabric is placed between the collection blanket and the low permeability layer, to protect the layer and to provide additional support to the overlying elements of the system. This drains any precipitation which infiltrates the cap to be drained off to discharge to nearby streams without becoming contaminated through contact with the waste. Often another permeable geotextile is placed on top of the drainage blanket, to keep it from being clogged by fine soil particles from the final layer. Finally, another 2' layer of soil is applied, to protect the cap and allow for vegetative stabilization.

Typical landfill closure cap section:

||||| Vegetative stabilization, to prevent soil erosion
: : : : :
: : : : : 2' of soil
: : : : : permeable filter fabric, to keep soil out of drainage layer
oooooooooooooooooooooooooooo 6' gravel drainage layer
oooooooooooooooooooooooooooo geotextile, to protect top of plastic
----- 40 mil PVC or HDPE impermeable layer*
: : : : : geotextile, to protect bottom of plastic
: : : : : 2' of soil
: : : : : Refuse

Questions? Contact the Solid Waste Compliance Division at (410) 537-3364.